

The Office of Environment, Safety and Health and its Office of Nuclear and Facility Safety (NFS) publishes the Operating Experience Weekly Summary to promote safety throughout the Department of Energy (DOE) complex by encouraging feedback of operating experience and encouraging the exchange of information among DOE nuclear facilities.

The Weekly Summary should be processed as an external source of lessons-learned information as described in DOE-STD-7501-96, *Development of DOE Lessons Learned Programs*.

To issue the Weekly Summary in a timely manner, the Office of Operating Experience Analysis and Feedback (OEAF) relies on preliminary information such as daily operations reports, notification reports, and, time permitting, conversations with cognizant facility or DOE field office staff. If you have additional pertinent information or identify inaccurate statements in the summary, please bring this to the attention of Jim Snell, 301-903-4094, or Internet address jim.snell@hq.doe.gov, so we may issue a correction.

Readers are cautioned that review of the Weekly Summary should not be a substitute for a thorough review of the interim and final occurrence reports.

Operating Experience Weekly Summary 97-21

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EVENTS

1. CHEMICAL EXPLOSION AT THE HANFORD PLUTONIUM RECLAMATION PLANT

On May 14, 1997, a chemical explosion occurred at the Hanford Plutonium Reclamation Plant in a room where non radioactive bulk chemicals were mixed for the now-discontinued plutonium recovery process. The reclamation plant was designed to concentrate liquid feeds, dissolve and process solid material, and perform solvent-extraction recovery of plutonium from aqueous streams. Eight workers outside the plant at the time of the explosion complained of various symptoms, including headaches, light-headedness, and a strange metallic taste. All eight workers were transported to a nearby medical center, where they were examined and released. A small fire protection water line ruptured during the explosion, resulting in the release of water from the building. No one was injured and no radioactive materials were released to the environment. The explosion caused significant localized damage to the facility. (ORPS Report RL--PHMC-PFP-1997-0023)

The acting manager at the Department of Energy (DOE) Richland Operations Office appointed a team of experts to investigate the accident, determine the cause of the explosion, and recommend corrective actions to prevent a recurrence. The investigation is in progress, and Operating Experience Analysis and Feedback engineers will prepare an article for a future issue of the OE Weekly Summary when the final results become available.

Investigators determined that the explosion occurred in a tank containing a solution of hydroxylamine nitrate and nitric acid. Based on preliminary information, they believe the tank contained less than 40 gallons of the solution. The tank initially contained a relatively dilute solution of hydroxylamine prepared for a training exercise in 1993. Investigators believe that, because the tank was vented, evaporation caused the concentration of the reactants to increase over time. Initial indications are that a spontaneous reaction of the two chemicals generated large quantities of steam and gas that overpressurized the tank. Investigators found no indications of a fire. Investigators have also determined that data collected during normal shift surveillances since 1993 indicated a concentration change was occurring in the tank. They believe that facility personnel did not recognize the significance of that indicator.

Historically, DOE has required the use of numerous chemicals in a variety of missions. These range from common acids, bases, and oxidizing agents to specialty organics, explosives, and hydrocarbon fuels, to toxic, corrosive, or flammable gases. In February 1994, the Secretary of Energy directed the Assistant Secretary of Environment, Safety and Health to undertake a comprehensive review of chemical safety practices and programs to identify chemical safety vulnerabilities confronting the DOE complex. The Assistant Secretary established a Chemical Safety Vulnerability Working Group to perform the review, taking into account the extent, diversity, and (all too often) uncharacterized condition of hazardous chemicals at many DOE facilities. The review was an integral part of the Department's overall strategy to increase the emphasis on safe and effective handling, use, and disposal of hazardous chemicals and to raise awareness about important issues related to chemical safety. Timing of the review was also particularly important because of a fundamental shift in the DOE mission away from defense nuclear production toward environmental clean-up and restoration.

The working group team members used sampling techniques intended to provide a representative cross-section of DOE facilities to select facilities for review. They considered

a number of factors, including the nature of operations performed; the status of the operation; and the quantities of chemicals involved. The results of the study are documented in DOE/EH-0396P, *Chemical Safety Vulnerability Working Group Report*. The working group identified three types of vulnerabilities: facility-specific, site-specific, and generic (those affecting the entire DOE complex). They identified the following eight generic vulnerabilities from the facility-specific and site-specific vulnerabilities.

- abandoned chemicals and chemical residuals
- past chemical spills and ground releases
- characterization of legacy chemicals and wastes
- disposition of legacy chemicals
- storage facilities and conditions
- conditions of facilities and support systems
- unanalyzed and unaddressed hazards
- inventory control and tracking

In addition to the generic vulnerabilities, the working group identified management weaknesses in chemical safety at the DOE sites. These weaknesses manifest as deficiencies in five programmatic areas.

- management commitment and planning
- chemical safety management programs
- aging facilities that continue to operate
- non-operating facilities awaiting transfer to the DOE Office of Environmental Management for deactivation, decontamination, and final disposition
- resource allocation

These five programmatic deficiencies form the basis for eight of the tasks proposed in DOE/EH-0398P, *Management Response Plan for the Chemical Safety Vulnerability Working Group Report*. These tasks identify the actions and programs needed to address both generic vulnerabilities and programmatic deficiencies and are typically improvements on on-going efforts. To address the facility- and site-specific vulnerabilities, responsible DOE and site-contractor line organizations developed site response plans. These plans are also included in the report. DOE/EH-0396P, volume 1, and DOE/EH-0398P, volume 1, are currently available on the DOE Chemical Safety Program Home Page. The URL for the home page is http://tis.eh.doe.gov:80/web/chem_safety/. Additional volumes of the report will be added as portable document format files become available.

In addition to the work performed by the Chemical Safety Vulnerability Working Group, another working group performed an assessment of the vulnerabilities associated with the storage of plutonium at DOE facilities. Many of the findings and vulnerabilities identified

during that assessment parallel those of the chemical safety study. These are documented in DOE/EH-0415, *Plutonium Working Group Report on Environmental, Safety and Health Vulnerabilities Associated with the Department's Plutonium Storage*. Specifically, the report identifies vulnerabilities associated with reactive materials in sludge and solutions and the storage of reactive chemicals in gloveboxes. The report also discusses inadvertent transfers of chemicals between tanks that can lead to undesirable chemical reactions.

Numerous events involving hazardous chemicals have been documented at DOE facilities. In 1976, an exothermic reaction occurred in an americium recovery resin column at the Hanford Plutonium Finishing Plant, and the column exploded. The force of the explosion shattered windows on a glovebox and plutonium and americium were expelled into a room. One worker in the room was highly contaminated. In 1990, an accident investigation board conducted a Type-B investigation of a foam generator feed tank rupture at the Savannah River Site. The tank violently ruptured approximately 2 minutes after an operator added 6 gallons of concentrated nitric acid and 2 gallons of an organic foaming agent to the tank. Investigators determined that facility personnel had not conducted a process hazards review or a review of what other chemicals could be mixed with the foaming agent. NFS has reported on numerous hazardous chemical events at DOE and industry facilities.

- In September 1992, a 2-gallon nalgene bottle exploded at the National Renewable Energy Laboratory. The bottle contained a chemical waste mixture of sulfuric acid, hydrogen peroxide, and nitric acid. The explosion occurred approximately 10 minutes after facility personnel closed the container. (ORPS Report CH-NA-NREL-NREL-1992-0007)
- In September 1992, a fire and explosion occurred at a commercial nuclear fuel facility in Irwin, Tennessee. Materials involved included highly enriched uranium and nitric acid. This event was similar to one that occurred at the Idaho National Engineering Laboratory in 1991. At Idaho, three workers were sprayed with an uranium-bearing nitric acid solution when a small explosion ruptured a borosilicate glass dissolver.
- In 1993, an underground tank exploded at the Russian Tomsk-7 Nuclear Processing Plant in Siberia. The explosion occurred when concentrated nitric acid was added to a tank already containing a solution of uranium and plutonium nitrates, trace fission products, and organic materials (primarily tri-*n*-butyl phosphate). The resulting explosion heavily damaged the facility, ignited several small fires, and spread contamination over parts of the surrounding countryside.
- In June 1995, personnel at Rocky Flats reported that concrete floor slabs in two buildings could be degrading because of spills of kathon (lithium chloride) from kathon units in the buildings. A similar event was reported at the Oak Ridge Y-12 Site in July 1996. (ORPS Reports RFO--KHLL-SOLIDWAST-1995-0001 and ORO--LMES-Y12NUCLEAR-1996-0017)
- On January 17, 1997, personnel at the Oak Ridge Y-12 Site discovered two legacy containers of lithium metal that were not completely submerged in mineral oil or inerted as required for safe storage. Lithium metal is highly reactive when exposed to moisture or air and burns vigorously at 180°C (356°F). (ORPS Report ORO--LMES-Y12SITE-1997-0003)

NFS provides guidance in DOE/NS-0013, Safety Notice 93-01, "Fire, Explosion, and High Pressure Hazards Associated with Waste Drums and Containers," February 1993, that will help facility personnel who handle and store drums and containers of hazardous materials. Safety Notice 93-01 can be obtained by contacting the Info Center, (301) 903-0449, or by writing to ES&H Information Center, U.S. Department of Energy, EH-72/Suite 100, CXXI/3, Germantown, MD 20874.

The following DOE and industry documents provide valuable guidance for all personnel who work with chemicals and hazardous materials.

- The Office of Environment, Safety and Health provides information in DOE/EH-0296, "Mixing of Incompatible Chemicals," February 1993, about the hazards associated with mixing of incompatible chemicals.
- DOE-HDBK-1100-96, *Chemical Process Hazards Analysis*, February 1996, and DOE-HDBK-1101-96, *Process Safety Management for Highly Hazardous Chemicals*, February 1996, provide guidance for DOE contractors managing facilities and processes covered by the Occupational Safety and Health Administration (OSHA) Rule for Process Safety Management of Highly Hazardous Chemicals (29 CFR 1910.119). Both handbooks are available on the Department of Energy Technical Standards Home Page at URL <http://www.doe.gov/html/techstds/standard/standard.html>.
- DOE Defense Programs Safety Information Letter, SIL 93-04, *Lessons Learned from Radiochemical Tank Explosion at Tomsk Russia*, July 1996, provides corrective actions and recommendations concerning equipment, operations, and controls to prevent Tomsk-like accidents at DOE facilities.
- DOE Defense Programs Safety Information Letter, SIL 96-01, *Incidents from Chemical Reactions due to Lack of or Failure to Follow Proper Handling Procedures*, June 1996, provides guidance to prevent these incidents.
- DOE Defense Programs Safety Information Letter, SIL 96-02, *Adequacy of Process Vessel Venting Capacity*, July 1996, addresses vessel venting problems like those associated with the Tomsk event.
- DOE Defense Programs Safety Information Letter, SIL 96-05, *Compatibility Considerations in the Mixing of Waste Chemicals*, November 1996, addresses these issues and provides a guide to available information.
- OSHA Regulation 29 CFR 1910.119, *Process Safety Management of Highly Hazardous Chemicals*, contains the requirements for preventing or minimizing the consequences of catastrophic releases of toxic, reactive, flammable, or explosive chemicals. OSHA Regulation 29 CFR 1910.119 is available on the OSHA Home Page at URL http://www.osha-slc.gov/OshStd_data.
- National Research Council Publication ISBN 0-309-05229-7, *Prudent Practices in the Laboratory: Handling and Disposal of Chemicals*, 1995, provides guidance and recommendations regarding the safe handling and

storage of chemicals, primarily in laboratory settings. However, the information can be adapted to other settings and situations. Information on how order this book can be obtained from the National Academy Press, 2101 Constitution Avenue, N.W., Washington, DC 20418. This book can also be ordered from most larger book stores.

Chemicals found at facilities in shutdown, transition, or deactivation mode may present additional hazards to those typically found in active facilities. Chemicals remaining in shutdown vessels, piping systems, drums, or storage locations may be subject to long-term changes due to degradation or concentration, thereby increasing the associated hazards. OEAF engineers recommend that cognizant facility personnel assess the condition of chemicals subject to potential long-term storage, even though the safety of an active process has been analyzed and assured. Long-term changes could lead to spontaneous reactions such as corrosion-product catalyzed reactions, slow chemical degradation, concentration by evaporation, or inadvertent cross-contamination caused by system leaks or misrouting of transfers. OEAF engineers suggest that facility managers review existing vulnerability assessment corrective action plans, the issues associated with recent hazardous chemical events, and surveillance data to ensure they have a good understanding of their chemical inventories and respond accordingly. A thorough review of the documentation cited in this article is highly recommended.

KEYWORDS: chemicals, chemical safety, vulnerability studies

FUNCTIONAL AREAS: Chemistry, Industrial Safety, Materials Handling and Storage

2. **WRONG CRITICALITY SAFETY INFRACTION POSTINGS REMOVED**

On May 13, 1997, at the Rocky Flats Environmental Technology Site, a process specialist incorrectly removed 19 criticality safety infraction warning postings. The process specialist was supposed to remove only the postings associated with raschig-ring tanks. However, the process operations manager who assigned the task did not specifically indicate which postings to remove, and the list he gave the specialist included every criticality infraction for the building. This breakdown in communications and work control resulted in removing criticality postings that affected over 15 rooms within the building. The removal of the wrong criticality safety infraction postings constituted a separate criticality infraction. (ORPS Report RFO--KHLL-771OPS-1997-0024)

Criticality engineers recently completed a technical re-evaluation of raschig-ring criticality infraction issues. They recommended removing the postings from the infringed raschig-ring tanks. Building support personnel coordinated the effort to remove the postings with criticality engineering and building operations personnel. The building support engineer requested a list of the raschig-ring tanks from the criticality engineer. The criticality engineer printed out a copy of the database that contained all criticality infractions, because he thought it would be best to print the entire list rather than sort out just the raschig-ring items. The majority of the raschig-ring items were on the first few pages of the list, so the building support engineer incorrectly assumed the entire list was raschig-ring only. He turned the list over to the process operations manager to have the postings pulled. The process operations manager, also believing the list contained only raschig-ring issues, gave the list to a process specialist and told her to remove the postings.

Over the course of 3 days, the process specialist referenced the database list and removed the postings. Another process specialist, more experienced with nuclear material safety limits, outstanding infractions, and general criticality issues within the building, was assigned

to complete the task and associated paperwork. He discovered that postings other than the raschig-ring infractions had been removed. He notified the shift manager who terminated the activity and limited access to affected areas of the building. Criticality engineers provided written guidance for operators to re-post the areas where the wrong postings were removed.

Investigators determined that the scope of the work activity was large enough to have been included in the plan-of-the-day. They also determined a pre-job briefing should have been performed. The shift managers, who normally control activities in the building, were more in the role of being informed of the task, rather than in control of it. Building support, operations, and criticality engineering personnel actually planned and controlled the removal of the infraction postings. Investigators also determined that the process operations manager did not clearly communicate the nature of the job to the process specialist or indicate exactly what to remove. The process specialist, who pulled the nuclear criticality safety infraction postings did not usually perform this function and was unfamiliar with the criticality issues.

This event illustrates weaknesses in the conduct of operations. These weak areas included (1) the authorization and control of work, (2) the assignment of personnel, (3) the direction provided by supervision, and (4) the general communication and transfer of information. The responsibility for ensuring adequate planning and control of work activities resides with line management. DOE 5480.19, *Conduct of Operations Requirements for DOE Facilities*, chapter II, states that the on-duty shift supervisor should maintain authority and responsibility for all facility operations. Facility managers and supervisors should ensure plan-of-the-day meetings or pre-job briefings are performed so the responsibilities of personnel are clearly defined and the expectations of the task are correctly understood. The misunderstanding regarding the information on the criticality infraction list demonstrates the importance of practicing clear, succinct communications between workers, supervisors, and organizations. DOE-STD-1031-92, *Guide to Good Practices for Communications*, discusses the need for clear, formal, and disciplined communications and provides guides to improve communications. DOE-STD-1050-93, *Guideline to Good Practices for Planning, Scheduling, and Coordination of Maintenance at DOE Nuclear Facilities*, provides information on work controls and coordination.

KEYWORDS: posting, nuclear criticality safety, work control, communication

FUNCTIONAL AREAS: Nuclear/Criticality Safety, Operations

3. FAILURE TO COMPLY WITH RADIOLOGICAL REQUIREMENTS

On May 15, 1997, at the Savannah River Site, a deputy operations manager noticed that a vending machine vendor did not have the required thermoluminescent dosimeter (TLD). He was one of two vendors who entered the facility to relocate a vending machine. The vendors also had driven through a radiological work permit/dosimetry-required area without an escort. The deputy operations manager provided the vendor with a TLD, apprised both vendors of the entry requirements, and assigned someone to escort them while they remained in the facility. The breakdown in compliance with radiological controls could have resulted in personnel radiation exposures and the spread of contamination. (ORPS Report SR--WSRC-ITP-1997-0016)

The entry requirements for the area included wearing a TLD, signing the standing radiological work permit, and either completing radiological worker I or II training or being escorted. Investigators determined that neither vendor had signed the standing radiological work permit or watched the video for facility access training. The vendors also entered the facility without reading the signs at the entrance to the TLD/dosimetry-required area. Investigators determined that the Westinghouse subcontract technical representative needs to ensure that vendors and subcontractors are aware of facility access and radiological requirements.

A similar event occurred on May 5, 1997, at Hanford, where two subcontractors entered a radiation buffer area without dosimeters to work on a leaking piping system. The subcontractors alarmed a personnel contamination monitor when they exited the radiological buffer area, alerting a radiological control technician to their presence. (ORPS Report RL--PNNL-PNNLBOPER-1997-0015)

NFS reported other related events in Weekly Summaries 97-01, 96-15, 96-03, 95-39, 95-38, 95-28, 94-44, and 94-32. NFS also reported assessments of civil penalties for radiation protection violations under the Price-Anderson Amendments Act in Weekly Summaries 97-01, 96-43 and 96-30.

- Weekly Summary 96-15 reported two events at Brookhaven National Laboratory involving personnel entry into controlled areas without proper authorization. On March 23, 1996, a shift supervisor found two contractors inspecting refrigeration machines in a radiation area. When questioned, the inspectors said they had not completed the required radiation worker training and had not been issued the required dosimeters. On April 3, 1996, a contractor entered a filter room, moved a radiation barrier, and entered a radiologically controlled area before post-cleanup contamination survey results were received. (ORPS Reports CH-BH-BNL-PE-1996-0005 & -1996-0007)
- Weekly Summary 95-38 reported that on September 18, 1995, at Richland, two visitors entered a radiologically controlled buffer area without dosimeters. Building managers implemented corrective measures that included (1) developing training on access control, (2) posting a notice at the reception desk and at the entry to radiological areas indicating that dosimetry is required, and (3) implementing a procedure on visitor access control and escort responsibilities. (ORPS Report RL--PNL-325-1995-0015)

This event illustrates the importance of understanding and following posted radiological entry requirements. Facility managers must ensure that subcontractors and visitors understand and abide by entry requirements for controlled areas. DOE EH-0256T, *Radiological Control*

Manual, contains guidance on training, access restrictions, and escort requirements for visitors at DOE facilities. Three articles in the manual, 336, "Visitor Entry Requirements"; 622, "Radiological Orientation for Visitors"; and 657, "Specialized Visitor Training for Tour Groups and Visiting Dignitaries, Scientists and Specialists," provide guidelines that are especially significant. Facility managers with responsibilities for escorting visitors should review their programs for compliance with the Radiological Control Manual.

KEYWORDS: personal dosimetry, radiological monitoring, training

FUNCTIONAL AREA: Radiation Protection

4. DEDICATED EMERGENCY EQUIPMENT USED FOR NON-EMERGENCY OPERATION

On May 14, 1997, at the Savannah River Site, construction workers used a ventilation unit dedicated to emergency ventilation of tanks at the F-Tank farm to provide additional ventilation for a tank they were filling with grout. This ventilation unit was required to be maintained as a dedicated, ready-for-emergency use system per the facility operational safety requirements. The construction workers obtained the unit on April 25, 1997, and a fire protection coordinator discovered it missing from its storage location during a walk-down of the facility on May 14. Operators retrieved the dedicated unit, performed a functional test on it, and returned it to storage. Improper or unauthorized use of dedicated equipment renders it unavailable to perform its dedicated function and may violate operational and technical safety requirements that represent the minimum acceptable controls needed to ensure safe operation. (ORPS Report SR--WSRC-FTANK-1997-0006)

Construction workers were filling a tank with grout as part of the tank close-out process. They connected exhausters to the tank risers to maintain a negative pressure in the tank. When the job supervisor asked the workers to find an additional exhauster, they obtained the dedicated unit from the storage facility, even though both stenciling on the unit and a sign specified emergency use only.

Each tank in the tank farm has its own ventilation system. If the ventilation system becomes unavailable, operators must restore ventilation to the tank within 1 week. If they cannot meet this requirement, operators can install a back-up, portable ventilation system that consists of a generator, exhauster, high-efficiency particulate air filter, and ducting. The operational safety requirement specified the need for a back-up, portable ventilation system, and an interpretation letter dedicated the back-up unit for emergency use only.

Investigators determined that the workers did not realize the unit was dedicated for emergency use. They also determined the usage requirement was posted, but the equipment was not as well isolated from other equipment as it should have been. The facility manager directed storing the back-up ventilation unit in a fenced area and posting signs on all sides of the fence. He also directed personnel to conduct a review to identify other programmatic access control problems (e.g., source control and lockout/tagout control).

This event illustrates the importance of maintaining adequate control over equipment dedicated for back-up or emergency use. Facility managers should ensure that dedicated equipment is clearly identifiable and controlled to prevent unauthorized use. In this event, an operational safety requirement was violated because the dedicated ventilation system was being used and, therefore, was not available to perform its emergency function. DOE

5480.19, *Conduct Of Operations Requirements For DOE Facilities*, chapter VIII, "Control of Equipment and System Status," states that it is imperative for equipment and systems at DOE facilities to be properly controlled. Not only must the operating shift be aware of how equipment and systems will function for operational purposes, but to satisfy the design basis and operational limits, the proper component, equipment, and system configurations must be established and maintained. Other guidance for controlling equipment status can be found in DOE-STD-1039-93, *Guide to Good Practices for Control of Equipment and System Status*.

KEYWORDS: equipment, ventilation, tank, emergency, operational safety requirement

FUNCTIONAL AREAS: Operations, Licensing/Compliance